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ABSTRACT

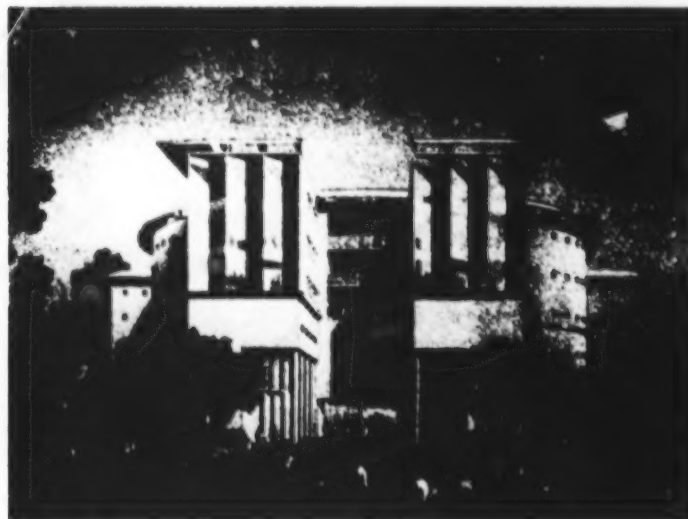
This document on successful scholarship in the sciences contains a keynote paper followed by six faculty responses. The keynote paper, delivered by Phillip Abelson of the American Association for the Advancement of Science (AAAS), is entitled "Assuring Successful Scholarship in the Sciences." Some of the factors likely to influence the nature of future scientific efforts, the evolving relations between universities and industry, the impact of governmental action on short term federal support for research, and some suggestions that the scientific community should consider for action are topics of discussion. The six faculty responses are from the following departments: Program in Social Ecology, School of Biological Sciences, Program in Information and Computer Science, School of Physical Sciences, School of Medicine, and School of Engineering. (KR)

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"Academic Libraries and the Sciences: Assuring Successful Scholarship"

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Program in Celebration of the
25th Anniversary
of the
University of California, Irvine
and
in Anticipation of Its New
Science Library



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Irvine, California
9 April 1991

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“Academic Libraries and the Sciences: Assuring Successful Scholarship”

**Program in Celebration of the
25th Anniversary
of the
University of California, Irvine
and
in Anticipation of Its New
Science Library**

**Tuesday, 9 April 1991
Eleven O’Clock
Cheng Hall, Irvine Barclay Theatre
Irvine, California**

**Lecture delivered by
Dr. Philip H. Abelson**
American Association for the Advancement of Science

followed by Six Faculty Responses:

Prof. Betty Olson
Program in Social Ecology

Prof. Patrick L. Healey
School of Biological Sciences

Prof. John King
Program in Information and
Computer Science

Prof. Ralph Cicerone
School of Physical Sciences

Dr. Richard L. Friedenber
School of Medicine

Prof. Roland Schinzinger
School of Engineering

Introduction

The University of California, Irvine Libraries had the opportunity to celebrate two special events during the academic year 1990-1991. The University has spent the entire academic year celebrating the 25th anniversary of the campus with various celebrations and programs. The contribution by the University Libraries was to also promote the Summer 1991 groundbreaking of the new science library, which is expected to be ready for occupancy in early 1994. These two special events encouraged the science librarians to sponsor a program, "Academic Libraries and the Sciences: Assuring Successful Scholarship," which was held on Tuesday, April 9, 1991 in the Cheng Hall at the Irvine Barclay Theatre.

A task force to plan and execute this program met for the first time in November, 1990 and was composed of Julia Gelfand, Applied Sciences Librarian; Mary Ellen Goddard from the University Archives; Kathryn Kjaer, Physical Sciences Librarian; Locke Morrissey, Engineering Librarian. Once the theme of the event was determined, an invitation was extended to Dr. Philip H. Abelson, known for his three decades of affiliation with Science and the American Association for the Advancement of Science to give the keynote address. That talk was followed by six members of the UCI faculty serving as representatives of the Schools or Departments whose basic library collections would be located in the new Science Library, responding to the issues presented by Dr. Abelson. This document chronicles as a proceeding of those talks and comments.

The Task Force acknowledges support for this event from the following sources: The Librarians Association of the University of California, Irvine (LAUC-I) and the Friends of the UCI Library each generously contributed to making sure this program took place. Encouragement and support also came from Dr. Calvin Boyer, University Librarian and Mr. Michael Homan, Assistant University Librarian for Sciences.

Welcome

The celebration of the Science Library is the culmination of many efforts. In electing to build a consolidated science library, the University of California, Irvine has run counter to the trend of decentralized library units. This decision has affirmed its commitment of support for interdisciplinary instruction and research. By combining our separate science collections and staff into a single facility, the Library can provide faculty and students ready access to multidisciplinary information and services at a level found on few other university campuses.

James Stirling, our principal architect, has created a design which integrates into one structure a campus presence and a building offering a rich balance between functionality and elegance. The articulated design provides a wide variety of study environments. The layout of each floor provides a special visual orientation enabling users to locate their destinations readily. The design also capitalizes upon the Southern California environment by providing natural light during the daytime to an unusually large portion of readers and upon the specific siting by allowing artificial light from within the building at night to telegraph the function of the building to those approaching.

No other single university science library in this country combines the breadth of science materials that will be housed in this building. Given the burgeoning primary and secondary populations which this Science Library will serve, its significance to the University and those it serves can only increase from opening day.

Calvin Boyer
University Librarian
Spring, 1991

Opening Remarks

Chancellor Jack Peltason
University of California, Irvine

We now are coming to the close of our 25th anniversary year. We have some more celebrating to do. Nothing is more important I think in this 25 year anniversary, than to reflect and celebrate. It is especially appropriate that we come today to talk about the Science Library. The ability of this faculty and staff and students to work together in these 25 years has transformed this campus into a dynamic and ever-growing university. Essential to that growth is the growth of our libraries. These libraries were important to us from the very beginning — from the first day we opened, and they've become increasingly so in the 25 years that have intervened.

What were first considered by many to be nothing but warehouses to keep books, have now evolved into the powerful information access facilities with their own online catalogs and multiple data bases, CD-ROM stations, and more to come. We've always said the libraries are the heart of the universities. That has been increasingly true as we move into the modern era where knowledge has been growing at a faster and faster rate with more and more new technologies to deliver it to the people who need it.

The Science Library seems to me to be an especially appropriate thing for this institution, which from the day it was conceived was committed to the three-fold mission of all universities (teaching, research, and public service) and nothing was so important to us. The founding chancellor, Dan Aldrich said that we're going to not only produce knowledge on this campus, but we have to make it available. Not just to the people who happen to be enrolled there as students, not just to the faculty, but that knowledge has to be delivered as quickly as possible, as effectively as possible, to all the people of California — indeed to all the people of the world. And so the Science Library takes its place in that tradition.

"Assuring Successful Scholarship in the Sciences"

Philip H. Abelson

American Association for the Advancement of Science
Washington, DC

An occasion commemorating the 25th anniversary of this university is a moment to view the scene from a long-term perspective. This is especially true when considering prospects for scholarship in the sciences. The circumstances in which research has been conducted have evolved greatly during this century and will certainly change during the next decades. New, vigorous fields have opened up often created by powerful but expensive instrumentation. The costs of conducting research are such that the level of effort is dependent on the extent of support by government, industry, or foundations. Societal attitudes which have become increasingly volatile will have large effects. In the past basic research was supported on the assumption that new knowledge would automatically lead to economic growth and other benefits for society. Now that view is being questioned, and in the future demands may be made that research be designed to achieve societal benefits.

In this talk I will speculate on some of the factors likely to influence the nature of future scientific efforts. I will later touch on evolving university-industrial relations, followed by treatment of some recent developments in the nation's capital that may in the short term impact federal support for research. Finally I will make some suggestions the scientific community should consider for actions.

There is general public recognition that scientific knowledge has been an important component in the development of technology. The knowledge base that scientists have created is a marvelous testimony to the capabilities of the human mind. Through teamwork of untold thousands of dedicated researchers a rich permanent endowment has been created for humanity. The treasure will be added to, and many benefits for society will flow from it through the millennia.

Scientific research does more than create knowledge. It also has the side effect of developing problem solvers and individuals who are alert to problems that society may be creating for itself. To be optimally effective in scientific research in the natural sciences requires a broad-based training in mathematics, physics, chemistry, and biology. This provides necessary tools to analyze phenomena and to identify crucial variables involved.

In the years that lie ahead, and particularly the fifty-year and more span that students here are likely to experience, many different societal problems will arise. There will be a pressing need for problem solvers.

In attempting to prepare for the future, we are handicapped by the inability to reliably predict it. That is especially true of more distant times. There are a few things we do know. There will be change. There will be great change. There will be unpleasant surprises. But some human needs will persist no matter what. There will be requirements for potable water, food, shelter, health care, energy, a livable environment, and a national defense. With the basic needs maintained, humans will search for amenities. They will wish to compete with others locally and internationally.

In some regions, shortages of potable water already exist. Additional development of superior membranes for reverse osmosis can help ameliorate this problem. In tropical regions, simple membrane filtration designed to minimize water-borne diseases is being developed.

Before the next fifty years have elapsed, world food problems are likely to be severe, especially if populations continue to expand. Applications of science will have a role in modifying the suffering. There are a host of opportunities for fundamental research in plant biology, much of which can be relevant to societal

needs. Some of the topics include natural mechanisms of pest resistance, mechanisms by which plants respond successfully to stress, and identification and fostering of presently underutilized food plants. In comparison to zoology and bio-medicine the tools of molecular biology have not been much devoted to plants.

In the United States, health care continues to improve. It is true that there are complaints about costs and availability, but in comparison to fifty years ago, the achievements are fabulous. Improvements will continue, and the quality and magnitude of our biomedical research effort guarantees better future standards of health care. The research will also bring new insights into complex puzzles that have intrigued biologists and many others. We will come to know in detail embryology and development from ovum to adult. We will be more informed about the role of genetics and disease. Ultimately we will comprehend better the workings of the human mind.

For the United States — and indeed most of the countries — a crucial determinant of standard of living will be modes of obtaining and utilizing energy. For us there is much to be done to improve efficiency of energy use. Most of the conveniences and amenities that we enjoy involve use of energy. Humans will not willingly give up the sense of power that control of energy devices brings. For example, consider the automobile. In spite of terrible urban traffic congestion, the traffic jams persist. We must improve the energy efficiency of transportation and other functions. This need is especially pertinent for devices that require liquid fuels. We should not and cannot be complacent about our long-term ability to import increasing amounts of oil. A tremendous effort involving research and development will be required to become more self-sufficient and to expand utilization of renewable energy such as bio-mass. The tasks involved in attaining improved energy efficiency and new energy sources will require the efforts of hundreds of thousands of scientists and engineers during the next fifty years and more. What we do about energy will, of course, impact environmental problems. Some of these such as urban ozone are local in nature. Of global concern is the greenhouse effect. Prudence dictates that we should find means of curtailing production of the greenhouse gases. Improvements in energy efficiency would lessen our existing large evolution of carbon dioxide. Were we to become more energy efficient, our technology might be transferable elsewhere.

Amelioration of past environmental mistakes poses another opportunity for scientists. During the next thirty years or more, vast sums of money will be expended in the clean-up. At present the techniques employed are sometimes ridiculous. One widely used method has been to move hazardous waste from one site to another. Moreover, there are uncertainties of factors of 10 to 100 in the level of toxicity of hundreds of substances. The mechanisms of toxicity of most of them are unknown.

At the moment, the United States is looked on as the one Superpower. But in the course of a few years, drastic changes can occur on the international scene. We should not attach great weight to the success in the Gulf War. Among other things, our weaponry was vastly superior. However, much of it was based on science and technology available 20 to 40 years ago. For example, Harold Brown, formerly president of Cal Tech as well as Secretary of Defense, has written that the Patriot missile was built using technology that was conceived in the 1960s. The technology of other powers will not stand still. Rather, efforts will be stimulated by the effectiveness of the U.S. weaponry.

At one time, military R&D was later adapted to civilian applications. More recently it is advances in civilian technology that are adopted by the military. In high civilian technology our global status has eroded.

In a report released March 20, 1991, the Council on Competitiveness rated the U.S. position in 43 areas involving electronic components and materials and associated processing technologies. The U.S. position rated strong in 8, competitive in 14, weak in 8 and losing badly or lost in 13. We were rated strong in biotechnologies including genetic engineering, but losing badly or lost in many aspects of electronics and electronic materials. Conversations with experts lead me to believe that we are losing ground in many areas of materials science. This is a matter that needs urgent attention.

Professor J.S. Langer of the Institute for Theoretical Physics at the University of California at Santa Barbara has stated the following:

...advances in materials underlie all of our modern technologies. Every manufacturing industry depends on materials research and development for the quality and competitiveness of its products. The field also has been remarkable in its growing intellectual vitality. One unmistakable sign of vitality is that truly major surprises are occurring at a rate of about one per year. A list of unexpected discoveries since about 1985... includes the quantized Hall effect, the scanning tunneling electron microscope, high-temperature superconductivity, quasicrystals, and diamond-film technology. The first three of these already have been recognized by Nobel Prizes.

I turn now to a discussion of computers. Their applications will obviously have additional great impact on national defense, the civilian economy, society and scientific research.

During the past twenty and more years the conduct of science has been impacted by the computer revolution. New frontiers for research have been created by scientific instrumentation made more powerful by incorporation of computer capabilities. Experts state the revolution will continue. The vice president for science and technology of the IBM Corporation recently estimated that computer technology will continue its dramatic improvement for as many as twenty years. He stated:

There is vast potential still left in the process of miniaturization, the technological engine which has driven our revolutions in computing and communication...Over a twenty year period there will be from 60 to 1000 fold improvement...By the year 2000, there will be one billion bit memory chips, microprocessors capable of 400 million instructions per sec, and magnetic storage of well over a billion bytes per square inch. That means, for example, the ability to store 100,000 printed pages on a square inch of disk surface.

Such developments will have profound effects on society generally. They will also affect the conduct of research by making complex phenomena more tractable. An important result for scientists will also be manifest in an improvement in access to the literature.

The operations of libraries are in the process of being revolutionized. The functions of librarians have been expanded from being custodians of collections to managers of information flow. With the proliferation of numbers of publications and expansion of the store of knowledge, the scientific information system had become unwieldy. Librarians have been alert to the opportunities created by electronics. They have been facilitating use of data bases and CD-ROMs. With enhanced speed of computation and improved memories, a remarkably efficient system will become feasible. In the changes that lie ahead the libraries at this campus will be among the leaders.

I turn now to a discussion of mechanisms for financial support of scientific research.

At one time it was feasible for a scientist to have a private laboratory in his home. Today, research is conducted at universities, government laboratories, and industrial facilities. The universities have a special role, for they educate potential scientists and conduct most of the basic research. About 50 of the so-called research universities receive the majority of the federal funds. The top 20 each receive roughly \$200 million/year. That kind of money necessarily impacts procedures and local value systems. It tends to make research preeminent over teaching.

A basic problem is that no one can measure in a convincing way the comparative quality of instruction in the various schools. In contrast, the dollars in grants or the number of research papers can be counted. One result is the creation of an environment in which there is tremendous pressure for professors to obtain grants. In some institutions a young assistant professor who does not have a grant cannot obtain tenure. Excellence in teaching is usually not a sufficient recommendation for tenure. At most research universities professors are expected to obtain part of their salaries from grants. At some places the required fraction is one-half. Much of the grant funds go to pay salaries of research assistants, including post-docs and graduate

students. A principal investigator may have as many as 100 assistants, though 12-25 is more common. To support such an empire the professor must obtain grants. Competition for funds has been increasing. Approval rates for grant proposals has been decreasing. Professors respond by writing more proposals. This creates more demands on peer reviewers. The professors have less time to inspire or supervise their troops. The system tends to encourage the proliferation of scientific papers. The system has been successful in creating scientific information. It has only been partially effective in addressing societal needs.

Knowledge generated by the various disciplines leads to benefits for society by various and differing paths.

Results of research on many areas of molecular biology and biomedicine is followed closely by clinicians and soon affects medical practice. Reports of discoveries related to health and health care are favorite topics of science newswriters and are well-received by the public. A huge majority of funds available from foundations go to medically related research. The public gives a high priority to matters that might affect people's health. In spite of some bad publicity that I will mention later, biomedical research will continue to enjoy support.

In few instances does the public highly value knowledge for knowledge's sake. An exception is astronomy. When people gaze at the heavens on a clear night, they are often filled with wonder and a desire for knowledge of what goes on in distant space. This wonder is manifest by the activities among amateur astronomers. While it is obvious that there are few practical benefits from astronomy, the public and its representatives have given the topic generous support. The astronomers have helped their cause by producing splendid visuals of astronomic objects.

The base of public support for chemistry and materials science is weak. To many people "chemical" is a fearsome, nasty word. The food we eat and the flowers we admire are a collection of chemicals, but absent considerable knowledge about chemistry, an individual fears the unknown.

The natural ally of academic chemists should be industry. And to some extent it is. Industry values the educational output of universities and the cutting-edge knowledge of professors. However, interactions with major companies have been only partially successful. Scientists in the two types of organizations have differing modes of operation and differing goals. Industrial scientists work in teams with an objective of creating profitable products. Insofar as they do basic research, it is to facilitate reaching a specific profitable goal. They also seek proprietary knowledge and know-how. These objectives contrast with academic scientists' emphasizing publication and grants.

Companies wish to exploit results of academic basic research and have experimented with a number of different types of interaction. A recent report issued by the National Academy Press provides comments by a number of officials of companies concerning forms of industry-university collaboration. These include participation in consortia, centers, affiliates, large multimillion-dollar university-single company alliances, and one-on-one interactions of university and industry scientists. The officials highly valued the one-on-one approach. They were cool toward other types of arrangements.

The scientific enterprise has entered a period in which the level of its value to society is being examined. This comes at a time when imperfections in the system are increasingly evident.

During the first three months of this year a series of events occurred that are likely to substantially affect the conduct of science at least in the near term. Some are more damaging than others. Two of them are likely to create continuing adverse publicity. Many of you are familiar with Stanford University difficulties with respect to charges for indirect costs. The sums of money misspent are small in comparison with the total involved in federal grants and contracts. However, minor indiscretions became major sins under the glare of publicity. Donald Kennedy, President of Stanford, is a distinguished scientist who has had an

honorable career of public service. He was embarrassed and made to appear incompetent in a Congressional hearing conducted by Rep. John Dingell (D-Mich.). The circumstances were such as to draw avid coverage by the media. The media love a scandal, particularly when a distinguished person or a famous institution is involved. For example an article in the influential *Washington Post* was headlined: "Antique Commode as Overhead Expense." The first paragraph of the story began:

Stanford University billed government research projects for expenses related to a \$1,200 antique commode, a \$10,000 set of donated silverware and a university-owned shopping center...

Stanford will be only the first of a number of universities that will be minutely examined. Minor but ridiculous misuse of government funds will be exposed. With guilt by association the integrity of management of other universities has already become suspect.

Already questions had been raised about misconduct of scientists. In the United States there are hundreds of thousands of scientists. A small number of recipients of federal grants have been found guilty of fraud or plagiarism. The majority of the miscreants were active in biomedical research. Incidents of fraud that were discovered several years ago drew some attention but probably not as much as that from two investigations that are more current. Controversy concerning the AIDS virus involving Robert C. Gallo of NIH will leave a scar. Even more damage will arise from a research publication involving Nobel Prize winner David Baltimore. Baltimore's name was on a paper that recently was withdrawn. The action came after years of investigation. Baltimore had stoutly defended the woman who conducted most the research reported in the paper. He had defended her vigorously during a Congressional hearing conducted by Representative Dingell. At the time many scientists believed that Baltimore had made Dingell look bad. The withdrawal of the paper by the man who is now President of Rockefeller University leaves Dingell with enhanced prestige. Many editorials critical of Baltimore have appeared. There had already been enough disclosure of misdeeds by others to lead to congressionally mandated actions by the major granting agencies, NIH and NSF. Both have offices charged with investigating scientific fraud and misconduct. Universities have found that they must devote the serious attention of high-level administrators to any allegation of misdeeds by their scientists.

The allegations of misconduct of institutions and individuals involve a limited number of examples. But in politics that is enough to be quite damaging. It can be used to tar the whole enterprise. The disclosures come at a time when scientists are especially concerned about budgets and their chances of obtaining federal grant support. In its budget for fiscal year 1992, the Bush Administration proposed increases for NIH and NSF, but they may or may not be implemented.

At the recent AAAS annual meeting, a plenary lecture by Representative George Brown provided information about budgetary prospects. Representative Brown of Riverside in California's 36th Congressional District is the new chairman of the Committee on Science, Space and Technology. He has been a member of Congress for nearly 30 years. He is one of the few members with training in science. His bachelor's degree was in applied physics at UCLA. His committee does not appropriate money, but he will be influential.

In his lecture Brown pointed out that the budgetary situation will be very tight, with most of the total budget committed to paying interest on the national debt, entitlement programs such as social security and medicare, and 20% to defense. Only 15% of the total or \$212 billion is left to cover all discretionary programs. The discretionary part of the budget was increased at about the rate of inflation. Thus, to increase allocations to NSF and NIH it was proposed to make cuts totalling \$10 billion from "community development block grants, crop insurance, senior citizen programs, low income energy assistance, family support programs and veterans benefits." Representative Brown commented that as the "Congressional debate over the budget gets under way, the advocates of each of these programs will be scanning the budget for additional funding sources, for areas that seem to be getting more than their fair share of the pie." He asked the audience, "And who do you think they're going to set their hungry eyes on?" Brown also made a number of comments that appear intended to alert the scientific community to important changes in attitudes on Capitol Hill.

For about thirty years after World War II a principal rationale for support of basic research was the hypothesis that basic research leads automatically to applied research and from then to new products, marketing, sales, and economic growth. But Representative Brown pointed out, as have others, that basic research is neither a necessary nor sufficient condition for vigorous economic growth. He cited the experience of Japan and Germany, whose economic growth occurred in the absence of significant funding for basic research.

Brown nonetheless stated that basic scientific research is an important part of our national research and development effort, but urged the scientific community to address the issue of how basic research can be most effectively carried out in order to provide the greatest benefit to society.

Returning to the matter of the budget crisis, Brown stated flatly that there will not be huge increases for the funding of basic research during the next 3-5 years. Accordingly, to maximize the effectiveness of limited resources he called for a process of setting priorities. He pointed out that with the tight budget, funds might be taken away from science. However, he was hopeful that such a diversion might be avoided if the voice of the science and technology community helped define research and development priorities. He further indicated his intention to have a significant role when he said, "The House Science Committee will play a central role in determining funding and policy priorities for research development. It is my firm intent to carry out this prioritization with the maximum possible input from the scientific community. In fact, a major objective of the chairmanship will be to increase the avenues of communication between scientists and Congress. I hope that many of you will take advantage of this opportunity to make your voices heard."

From my discourse about recent developments in the nation's capital it should be evident that at the moment the political climate for science is stormy. How long that will last or what its residual effects will be are uncertain. However, one should draw comfort from a paraphrase of a remark that the humorist Will Rogers once made. The gist of the remark was that if you don't like the weather in Washington, stick around for fifteen minutes. More than fifteen minutes will elapse before science appropriations bills are passed, probably in September or October.

Nevertheless it would be prudent for research universities to prepare for possible vicissitudes and to assess their strengths and vulnerabilities. The most important functions that universities perform are communication of knowledge and instilling in the young a desire for lifelong learning. If professors are conscientious and skilled in their instruction, they are instrumental in creating better citizens for society. Skill and care are especially desirable in the science courses for the non-majors.

Research output by universities is important, but not to the extent that is customary in many research universities. Some of the practices seem unhealthy. These include large groups under one principal investigator, extremely long times to the PhD degree, and an inferior priority for teaching. The scientific community has often been asked to establish priorities among different areas for research. No real effort has been made. I believe that a thoughtful multidisciplinary group could create a framework that Congress might find useful.

Many congressmen have remarked about the lack of interaction between themselves and scientists. There are institutions of higher learning in all congressional districts. Scientists should make themselves heard. However, the conversation when it occurs should be positive and optimistic. It should not be harshly critical of other scientists or their fields.

Today I gave discussed a wide range of topics, including major areas for future research and relationships of scientists to society. At the moment, there are frictions in the relationships. Such frictions will always exist, though taking different forms. But scientists will always have a relatively unique role in society. For the benefit of society they will add to a great endowment of knowledge involving natural phenomena, and when the inevitable new difficult problems arise, they will be problem solvers.

Faculty Response #1

Professor Betty Olson Program in Social Ecology

I want to begin by talking about how I became really enamored with the library which was when I was conducting my PhD research at Berkeley. Because I undertook a project that was interdisciplinary in nature, I found myself spending time in the Biological Sciences Library, the Engineering Library, the Library for Public Health. And at that particular time we roamed around the stacks and looked for books. But I see the library of the future as being something that may be extremely different.

We may sit at our terminals and be able to pull up a wide array of information from complex sources. Or we may be looking at a variety of different types of computer programs which can aid us in information sorting, allow us access to various genetic codes, or we may be looking into laws and policies from around the world. We're going to see with this proliferation of information and our ability to be able to store it in very tiny places, the access of information growing and expanding.

This is extremely important for interdisciplinary areas such as Social Ecology, where individuals from a variety of disciplines ranging from psychology to the natural and physical sciences, have joined together to understand societal problems and to increase our knowledge in the areas of mental health, law and society, criminal justice, and environmental science. Social Ecology strives, and requires information from a variety of sources. Our need for acquiring this information becomes more complex and difficult as we move materials into storage facilities so they're not readily at hand.

As we go forward we find that we have a growing need for scientists and engineers. Particularly in the area of environmental science when we try and look ahead at the wide range of problems which indeed face us on a global level. We know that there is a tremendous shortage of scientists and engineers, we know that we are going to face a variety of constraints. In light of Dr. Abelson's remarks are challenges scientists in the next decade will face and which will be indeed great.

Not only do we have this growing need for scientists, but we have a budget deficit that consumes, and will continue to consume, the majority of the discretionary budget in the United States. And I want to stress, this is not a problem just in the United States but it faces every state in this nation, where the discretionary budget becomes miniscule compared to entitlement programs and other programs mandated by law.

We also are facing a rate of information increase that is unparalleled. And perhaps somewhat excelled as we hear from our institutional "grant-getting" processes. But nevertheless, the need to access this material, and the need for libraries to make a transition will become evermore pressing in the decade that follows.

We're also faced, as we heard from Dr. Abelson's remarks, with public impression. And, most importantly in EPA's recent publication on unfinished business we saw that the public's view, or Congress's view of what are the important issues in the United States focused on hazardous wastes, while the majority of the scientific community ranked issues such as global climate change among the top. So we have this widening gap between public information and how it understands sciences. Certainly how we transmit information and how information becomes available to the public is extremely important in making sure that what is in the best interest of the nation and of the globe is continued to be sought vigorously, especially in times of budgetary constraints.

I feel that one of the most important functions that the academic institution has is the education of the public, particularly those individuals who are not pursuing a career in science, to give them an understanding of the complex issues that face the nation. To let them know the value of basic research as all of us in applied sciences know it from its everyday use in our laboratories. And to teach an appreciation and the value of technology and to remove it from the era of the 1960s when it was looked upon as only creating negative impacts and move it forward to solve many of our current problems.

We see then, as we go forward, we need a type of publication that will reach all the people and aid in transmitting science in a manner which is of great understanding. We do have some educational processes which are going forward. There's a program conducted every summer at Woods Hole, MA which seeks to educate the scientific press/media people in the advances in science that are going forward to increase understanding. I see in the near future for our libraries a tremendous task — a task where we'll still be maintaining the traditional mode which I used (parusing the library shelves), but we'll also be entering into a new mode, the mood of changing information into different formats and the amount of time and energy that will be required by our staffs in order to make it possible for us to meet the demands of the future; not only in all areas of basic research, but also in those very important societal ones.

Faculty Response #2

Professor Ralph Cicerone

School of Physical Sciences

Geosciences draws upon, and contributes to, progress in chemistry, physics, environmental microbiology, ecology, applied mathematics, political science, resource economics, meteorology and oceanography and other fields. There is a lot of enthusiasm at UCI for this new library but few if any people look forward to the integration of physical, biological and medical sciences libraries with those of engineering as much as Geosciences people do.

Dr. Abelson's perspectives have been formed over a very impressive career of his own scientific research and his amazing tenure as Editor of *Science*. They are clear and valuable and presented with impressive conciseness.

I share Dr. Abelson's view that there is a growing need to focus on the applications of science. He makes the distinction between basic science and technology but most people do not, for example, the general population and many individuals who support science from government agencies, foundations and corporations. More positively, there is some awfully good and important science to be done on some identified practical problems in the environment and health for, for example. My experience in research on "hot" problems along with watching others whose research is in the public eye has convinced me that the work is challenging and worthwhile. Amongst other factors, the quality of the work must be very high to be able to withstand the criticism that often arises from those with legitimate special interests.

In addition, there is a growing need for scientific attention to applied problems. Consider for example the demands placed on the environment and the infrastructure for human civilization by the growing human population. Every twelve days human numbers grown worldwide by about three million (about the population of Orange County); in some sense then there is a need for providing the water, food, shelter, transportation, electricity, waste disposal and other services for a new Orange County of people every twelve days. I doubt that the world is doing this and I doubt that we can do so without achieving very high levels of productivity and ability to protect the environment that sustains us, to say nothing about the aesthetics of the situation and of biodiversity.

Indeed, the demands on the scientific community and on educated people generally are growing so large that we must begin to anticipate the need of protecting the purer scientific endeavor that continues to make great and fascinating discoveries whether or not they lead to better technology or management tools. I do not think that it would be wise or effective to try to force too many scientists to work on applied problems.

Similarly, there is no need for everyone to be a scientist. Instead it is important that we at universities and people everywhere respect the constructive enterprises of others and that we appreciate all high-quality efforts toward constructive goals. Dr. Abelson's call for special attention to college courses on science is very appropriate; I hope that we can continue to present and improve such opportunities for UCI students and that these courses will be appreciated not only at the time but throughout the lives and careers of UCI's graduates.

Faculty Response #3

Professor Patrick L. Healey
School of Biological Sciences, and
Director, Instructional Development Services

Dr. Abelson, Dr. Boyer, colleagues and friends: While the Age of Biology may be dated from the publication of Charles Darwin's *On the Origin of Species* in the mid 19th century, modern biology began with the 1953 paper in *Nature* by James Watson and Francis Crick proposing the structure of DNA.

That event marks the restructuring of biological scholarship from the traditional study of organisms in fields of Botany, Zoology and Microbiology, to one which recognized the many similarities of the genetic and cellular makeup of all organisms.

The new approaches to the study of life lead to the reorganization of the academy into hierarchical levels focusing on the biological molecules, cells, organism and populations. One of the first institutions to make the change to the new structure of the study of biology was here at Irvine, under the direction of its founding Dean, Edward Steinhaus.

Beginning with Watson and Crick's revelation of the structure of DNA, molecular biology became the granddaddy of modern biology. Soon its concept and techniques permeated old biological disciplines and gave rise to new ones. Major advances in genetics, cell biology, developmental biology and evolution are now largely based on molecular biology, as well as important aspects of neurobiology.

Applications of modern biology have advanced fields of medicine, agriculture and environmental management. New fields of genetic engineering and biotechnology have provided important advances to the service of humankind and greater promise for the future.

This explosion of new ideas and concepts in both the basic and applied areas of the biomedical sciences has, of course, given rise to an even greater increase in information. Hundreds of new journals have been spawned during the past forty years and others have increased in the number of pages per volume.

Fortunately, the card catalog method of information management is behind us. Without new technologies like MELVYL, MEDLINE and other bibliographic databases it would be close to impossible to keep track of the journal titles, let alone the information in the articles.

Much of the new information is important, or at least useful. But a great deal of it, at least in many of the lesser journals, is less, much less, than earth shattering. Because of the pressure to publish, there is a great deal of verbal filler and duplicated information to further add to the bulk of information and make it even more difficult to separate the wheat from the chaff.

Biological information cannot continue to expand exponentially and indefinitely, as it has for the past forty years. Some greater degree of quality control must be applied. This change, in fact may be encouraged, if not dictated from outside. Federal and State budget deficits do not look as if they will go away as easily as they have in the past. It is time to pay the piper.

In addition, applications for graduate studies in the biological science at universities across the nation have been decreasing in number. We as faculty need to spend more time replacing the seed corn of our

profession — the next generation of biomedical scholars. To do this, new populations of undergraduate and graduate students, which better reflect the increasing diversity of our citizenry, must be recruited, motivated and well educated to be the biologists of tomorrow.

We are entering an era of great opportunity when we can address what some people, such as biologist Donald Kennedy, President of Stanford University and Ernest Boyer of the Carnegie Foundation for the Advancement of Teaching, believe has come to be an imbalance in the academy. Kennedy has initiated a fundraising campaign to support a program aimed at increasing the quality of the undergraduate education at Stanford.

Boyer has authored a special report of the Carnegie Foundation titled, *Scholarship Reconsidered: Priorities of the Profession*. In it he states, "...the most important obligation now confronting the nation's colleges and universities is to break out of the tired old teaching versus research debate and define, in more creative ways, what it means to be a scholar. It's time to recognize the full range of faculty talent and the great diversity of functions higher education must perform." He proposes four general views of scholarship — discover, integration, application and teaching.

About the faculty, Boyer asserts, "The richness of faculty talent should be celebrated, not restricted. Such a mosaic of talent, if acknowledged, would bring renewed vitality to higher learning and the nation."

It is my hope and belief that the University of California, Irvine, will address a new definition of scholarship in the near future.

Faculty Response #4

Dr. Richard Friedenberg

Chief, Department of Radiological Sciences
School of Medicine

From what one reads today, it would seem that support for education and research is perhaps more verbal than practical. Whether we are dealing with the sciences or humanities, support is a major problem. The algorithm for today relates to cost-effectiveness, and there is a danger that this will be obtained at the expense of quality. Dr. Abelson has discussed the various areas of support for scientific research which have more recently included industrial support.

In health sciences, we have become sensitive to the necessary interaction between medical research and industrial goals, as mentioned by Dr. Abelson. The problem, as he points out, is for medical research to be relevant to industrial needs, which hopefully relates to societal goals. We at UCI have formed several cooperative ventures with industry, although not yet on as major a level as in some universities, and are planning more such relationships in the future. This will be a major source for growth if federal support diminishes. One problem is that industrial research is perceived as conflicting with our concepts of academic freedom, since industry has a need for secrecy and will limit their support to very specific areas. However, this problem presently affects all current scientific research, which is frequently led toward those areas where support dollars are available. Education of both industrial leaders and scientific investigators is required to make this a more symbiotic relationship.

The original concept leading to the establishment of university centers was a desire to have a method of passing knowledge to future generations — universities are the centers of learning. As Dr. Abelson stated, they are for the communication of knowledge and for instilling a desire for lifelong learning. We sometimes lose sight of this mission in our quest for the quantifiable dollars available for research, and because recognition and advancement is easier through quantifiable papers and research dollars than through education. Research, of course, is important, but not to the extent of decreasing the effectiveness of teaching, which may be happening in many university centers. Priorities have to be re-evaluated and then methods of support and means for advancement adjusted to these priorities.

As Dr. Abelson stated, the public often questions whether some of our present research will provide new knowledge which will benefit society. This is no way more apparent than in the development of expensive technology which has amazing potentials for benefit, but without controls also has amazing potentials for waste. This has to be organized in a manner which will provide the most health dollar for society or we may see a resistance to future support of technological developments. Technology has provided enormous health benefits but at a significant cost. I can foresee a time in the future when we will approach an era of noninvasive biopsy — when imaging and metabolic evaluations performed simultaneously may provide histological information about body structures without the need for surgical biopsy — a "Star Wars" type medicine.

In the United States, we are providing the highest quality of health care, supporting major new technological developments, and providing major dollar investments into the best developed scientific community in the world. We have to learn to do this in a more cost-conscious atmosphere, where providers feel that they are getting accountability and are getting the biggest "bang" for the dollar. As Dr. Abelson stated, our achievements in health sciences have been remarkable, and future potentials in many areas such as genetics and neurosciences are mindboggling. Achievement in research is associated with significant waste. Not every research project is successful, for many reasons. There is a necessary, almost required amount of waste, which is in a way a by-product of achieving success. This becomes a target for critics who may condemn research support — without understanding the difficulties inherent in the selection and support of research. In our cost-conscious society, this could be a problem in obtaining research support.

I would like to thank Dr. Abelson for his stimulating remarks on some of the problems relating to scientific scholarship in academia.

Faculty Response #5

Professor John L. King
School of Biological Sciences, and
Program in Information and Computer Science

The occasion today is auspicious. We are launching an important addition to the University of California, a new Science Library at Irvine. And we are hearing words of experience and sobriety from a leader of the American scientific scene — a person whose insights in his editorials in *Science* have long impressed me. If you permit me the liberty, I won't comment much on the role of information technology in the new library, or on the relationship of computer science to that library. Suffice it to say that we in computer science were concerned about these things, and we made every effort to find out if Cal Boyer had his mind right about them. He did, so we left it in his capable hands. The new library will be a showcase, I think. So instead of commenting on information technology and the new library, I shall take the two bearing points of the creation of this library and Dr. Abelson's comments to note some thoughts that have been on my mind of late.

The role of the library in the history of the academy cannot be overstated. Scholarship as a science probably first emerged in the 3rd century BC when the great Library was established as a part of the Museum, or temple of the Muses in Alexandria. We cherish the memory of that great library, which was possibly the first university as we would think of it today. The main purpose of the library was to bring together scholars to work on problems of literary analysis, for example to establish the definitive text of Homer. This ambition prompted the ancient commentator Timon of Phlius to note, "In populous Egypt they fatten up many bookish pedants who quarrel unceasingly in the Muse's gilded bird-cage."

As a somewhat bookish pedant myself, I can relate to this characterization. And indeed there is a certain ring to this ancient quip in light of the modern academy. Perhaps the most important reflection we get from that distant mirror is this: that scholarship, by which I include science, has always been a controversial passtime, and remains so today. As Dr. Abelson's remarks aptly point out, we live in an era in which the products and the ideals of scholarship and science are held in high public esteem, but the institutions and processes by which they are produced — not to mention the people who produce them — are increasingly called into question. In the midst of our unceasing quarrels, pedantic and otherwise, we perhaps lose touch with that great population of people that I refer to, after some deliberation, as our *customers*.

I pick the term customer advisedly, despite the hackles it raises among some of my colleagues, because it is instructive to do so in light of some lessons we have learned about consumer behavior in the past twenty years. During the first six decades of this century, the American producers and the American consumers established a kind of curious pact. The objective or production in this pact was not to make products that were the best they could be. Indeed, the whole mission was to make products that people could afford. In this compromise, the goal of quality was simple: American products must be only good enough. In the past 15 years, international competition has challenged this view profoundly, and altered forever the economics of production in U.S. manufacturing.

Nevertheless, the attitude of "good enough" has left a legacy. It shows up in many sectors of society, and over time, it has wormed its way into the academy; but with a peculiar twist. We have segregated our customers into two classes. One class is our peers, the other scholars and scientists of the world, for whom no standard of quality can be too high. In so doing, the U.S. has produced the greatest flowering of intellectual talent in the history of the world. And of this, as Dr. Abelson notes, we can be justly proud. On the other hand, however, we have created a second class of customers that includes pretty much everyone else. It

includes our students, who might get what they pay for — especially in relatively inexpensive public universities— but who do not necessarily get what they *deserve*. It also includes our colleagues from the worlds of industry and commerce and to a somewhat lesser degree agriculture, who in one way or another pay for the bird cages we so enjoy, and from which they justifiably expect so much.

The great problem with this situation is that it is short-sighted. The long run, which I am afraid is upon us already, is beginning to bear this out. The problem here is one of vision, a mistaken vision in my opinion. Dr. Abelson's remark that the public recognizes that scientific knowledge has been an important component in the development of technology. I think this true, but unfortunately, I also think the public is misled in this regard. And they are probably misled by us. There is a connection between science and technology, but I think the causality usually goes the other way. This is a rather hotly disputed notion in contemporary economic history of science and technology, but the gist of it can be summed up by a remark from the economic historian Gillespie, in 1956, by the way, that "science owes more to the steam engine than the other way around."

Perhaps it is fair to say that the causal arrows run both ways. I'll accept that compromise. But we in the academy do ourselves and our customers a great disservice when we believe and argue that we give more to the world around us than we take from it. This belief is unnecessarily arrogant, and surely offputting to many of our customers — the kindest thing you can say about it is that it is a form of noblesse oblige. Most important, though, it robs us of the sensitivity and sensibility to look for the important problems that drive our inquiries in the places they are most likely to be found — our own backyards.

If it is our objective to assure successful scholarship in the sciences, even as we add yet another magnificent facility — a bird cage, if you will — to the Irvine campus, we should redouble our efforts to bring the university to the world, and not demand that the world come to the university. This new library, like the ideas for which it shall stand, belong to all of us. I hope and trust the new library will further UCI's great mission for the people of our region, state, nation and world.

Thank you.

Faculty Response #6

Professor Roland Schinzinger School of Engineering

Philip Abelson has left us with many insightful observations on the state of science and technology at the present time and what the future might hold. In my own comments I would like to go back to the matter of public sentiment which he considers to be a strong factor in science policy.

I have before me four newspaper clippings of recent days. The first three are from the *Los Angeles Times*:

1) Back in September one Richard K. Moore wrote this letter to the editor: "...What would parents see if they visited the elementary classrooms of California? The first thing they'd notice might be the television, hooked up to a VCR. Video has replaced film as the educational equipment of choice. In another corner they'll find another screen, attached to a computer...Where are the real books? The ones people can buy in bookstores? Trade books, the kind found in 49 states in school libraries and borrowed, read and treasured by children, are hard to find. In fact, you are more likely to meet a librarian if you are a convicted felon in California than if you are a child in school. Young offenders in the California Youth Authority have one librarian for every 700 criminals. Students in K-12 schools have one librarian for every 4,000 kids..."

2) On March 27th, Reva Robins began her letter to the editor by reminding us that because of a fire in 1986 the Los Angeles Main Library was still closed and that it will not reopen for "business as usual" until 1993. Then she gave us this shocking news: "The Los Angeles School Board, in its deliberations concerning budget cuts, hasn't set fire to the school libraries. But it has sent letters of dismissal and termination to 72 of its 128 school librarians. This is tantamount to closing the doors of 72 school libraries. Criminal?..."

3) The next day, March 28th, Times staff writer Jim Mann reported on what has been happening at the Japan-United States Friendship Commission. This is a government panel set up by Congress in 1975 with money from Japanese repayments to the US for American aid after the war and for public facilities the US had built on Okinawa. The Commission had regularly donated funds to 13 top American Universities, including UC Berkeley and UCLA, for the acquisition of Japanese language books and periodicals. Now it has stopped its book buying program so it can help develop the infrastructure which will allow fewer books to reach more places via new technologies and databases.

The last two items appear in the current (April 16) issue of *The Weekly World*, a fearless competitor of the *National Enquirer*.

4) SCIENTISTS PLAN TO BLOW UP THE MOON. How and why? Using nuclear explosives the moon is shred to pieces, the pieces are guided so they land in the southern part of the Pacific Ocean, the earth's axis is given a slightly different tilt, and sunshine is distributed more evenly around the earth, providing eternal spring.

5) DEFROSTED ICE MAN IS MARRYING HIS NURSE! American born Charlie Foster died of a heart ailment at age 35 in 1936 in Dresden, Germany. His wealthy family had him flash-frozen and stored in a cryogenics laboratory in Dresden. The World War II firebombing of Dresden is not mentioned, only that he has just been revived, that he has been cured by new medical treatments, and that he has married

a young hospital nurse. The article comes complete with a photograph showing him still encased in a block of ice like a giant popsicle.

The first two pieces tell us that California's school libraries continue to suffer the consequences of the tax revolt embodied in Proposition 13. So we in the universities had better be prepared for freshmen who are even less familiar with the use of libraries — or even the use of books. (But they might be better than many of their professors in using VCRs, PCs, and CDs, not to mention being more at home in this alphabet soup!) We shall face a compression of lecture time — as well as our own time or that of librarians, and of course that of the students — must be used to build library recognition.

Might something get lost anyway as new technologies are injected? Surely. Just as story telling suffered when the printed page appeared, so the imagination (the image forming) evoked by the passive page will suffer when a steady diet of movies with ready made pictures and sound can be conjured by command out of a box as if it were a candy dispensing machine. As an engineer who can get excited about inventions, I do not automatically oppose all that is new — I merely want to see the best of the old retained in some measure. This can take considerable effort in a technologically faddish society.

Item (3), the changing policies of the Japan-US Friendship Commission, are also occasioned by the advent of new technologies and their purported advantages. Time will tell how successful this change will be. At least the loss is not irretrievable as all the books will still be available in Japan. More to the point is the rising cost of translated journals, be they Japanese or Russian or Chinese in the originals. When there are not enough buyers left the journals will simply wither away. But then the translators can be hired as language teachers and we can all make greater efforts at becoming multilingual! In this respect UCI's foreign language requirement is a step in the right direction; let's hope it encourages students to complete their foreign language requirements before they complete high school.

Why did I mention the *Weekly World* in this august assembly? Because we are celebrating the building of a science and engineering library. And when it is completed it will receive heavy use from readers outside the university. Many will come to seek further information on interesting science newsbites, and they expect to find such information in our libraries. So we should also be ready with some antidotes to the outlandish. At the same time we must prepare our students to face the commercial world and recognize the impact of public tastes. It is not too farfetched to imagine that UCI graduates could be offered jobs with a cryogenic laboratory which promises to freeze the newly dead for later resurrection.

Our graduates may not believe that freezing/resurrecting would work, except perhaps from the financial angle, but will they be aware of the ethical and professional implications of accepting such jobs? Here our task is to make sure that the existence of a separate science and engineering library not signal the creation of a totally separate world for the technically oriented. Our breadth requirements combat such separateness, undergraduate students should be made to visit each of our libraries at least once before graduation.

My comments were occasioned by what Philip Abelson has told us. Science and technology are important to our wellbeing if properly used. As government support for research and other scholarly pursuits is shrinking, it gives us the opportunity to select the wisest way to spend what is available. How much time and money do we put into teaching, how much into writing more papers? How do we select our research topics? Do we consider societal effects? I believe that our future library acquisitions and the use of our library facilities will serve as good signposts of the directions we have chosen.